Potential use of GIS to determine farming impact on climate and climate impact on invasive species in Alaska

Alberto Pantoja, Jeff Conn, Dennis Fielding, Bonnie Furman, Nancy Robertson, Steven Seefeldt, and Lori Winton
Subarctic Agricultural Research Unit, Palmer and Fairbanks, AK

Introduction

Satellite imagery combined with GIS can be used for a variety of studies. In Alaska research results indicate that at high latitudes tundra plants absorb less solar radiation than shrubs and shrubs absorb less than spruce (Fig. 1) and that vegetation change from tundra to shrubs and shrubs to spruce accounts for up to 50% of measured warming at high latitudes (Chapin et al 2005). Our first objective is to determine if the conversion of boreal forest to crop land will result in less solar radiation absorption.

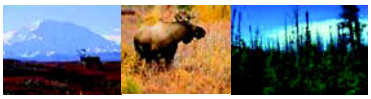

Fig. 1: Tundra, willow shrubs, and black spruce

Measured warming in high latitudes will have consequences for the spread on non-indigenous plant species. Our second objective is to determine where these plants will spread to and where best to manage them.

Impact of Farming on Climate

Based on farmer interviews and data collected at the Delta Junction Farm Services Administration, the Natural Resources Conservation Service and the United States Forest Service, we have GIS layers in ArcGIS ArcMap version 9.2 for land use (Fig. 2) and disturbance history (Fig. 3). The land use information details cropping history and management since the land was first cleared for agriculture (Fig. 4). Other layers include soils, climate, climax vegetation, water bodies, and permafrost.

Amount of absorbed solar radiation can be determined using multiple years of MODIS satellite imagery and these data will be added as a layers. Our unit will need added expertise to develop this study and validate the results of the research.

Fig. 2: Alaska farm fields with cropping histories

Fig. 3: Fire history in Delta Junction farming area

Fig. 4: Cropping history example

Year	Field DJ03069	DJ03068	DJ03070
1994	Barley	Barley	Barley
1995	Barley	Barley	Barley
1996	Fallow	Fallow	Fallow
1997	Let go	Let go	Let go
1998	Let go	Let go	Let go
1999	CRP-Mow	Fallow	CRP-Mow
2000	CRP	Brome	CRP-Mow
2001	CRP-Mow	Brome	CRP
2002	CRP	Brome	CRP
2003	CRP	Brome	CRP-Mow
2004	CRP-Mow	Brome	CRP
2005	CRP	Brome	CRP
2006	CRP	Brome	CRP-Mow
2007	CRP-Mow	Brome	CRP

Impact of Climate on Non-native Invasive Plant Species

Preliminary research based on CCCma climate data have been used to develop biogeographic models for predicting the spread of many non-native invasive plant species (Bella 2009). Giant hogweed (*Heracleum mantegazzianum*), a riparian invasive from Europe that is already established in Washington and British Columbia, grows 3 to 4 m tall, and has sap that causes blisters when exposed to the sun, could establish now in SE Alaska (Figure 5a). Based on climate projection, by 2080 it could spread into interior Alaska (Figure 5b). This plant will have negative environmental consequences in Alaska riparian ecosystems.

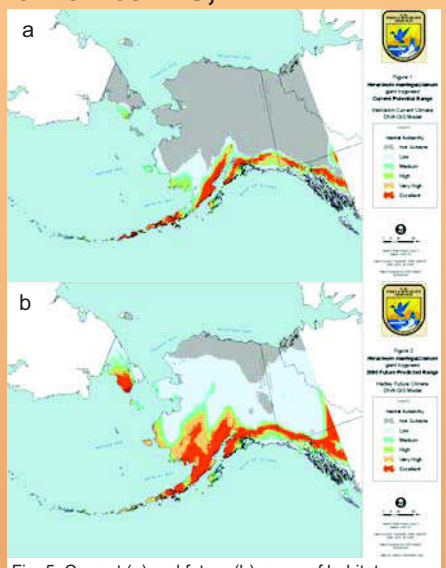

Fig. 5: Current (a) and future (b) range of habitat suitable for giant hogweed

Conclusions

The Subarctic Agricultural Research Unit is uniquely located near the tundra and boreal ecosystems that are found at high latitudes and are experiencing more rapid changes in climate than areas of lower latitude.

The unit has
- Two weed scientists
- Two entomologists
- Two pathologists
- One plant curator
- One plant physiologist/geneticist
- Collaborations with the University of Alaska Fairbanks and the Scenarios Network for Alaska Planning

To enhance our research we need
- Increased capability in remote sensing and GIS
- Increased capacity for developing biologically relevant plant growth models
- Development of data on how well invasive plants grow in various high latitude soils and topography

References

Chapin, F.S., M. Sturm, M.C. Serreze, J.P. McFadden and others. 2005. Role of land-surface changes in arctic summer warming. Science 310:657-660.

Bella E. 2009. Predicting invasive plant range expansion in Alaska through biogeoclimatic modeling: limiting factors in a changing climate. Dissertation.

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